National Aeronautics and
Space Administration

Spacecraft/Payload Integration & Evolution Element, Space Launch System Program
Marshall Space Flight Center AL 35812

Universal Stage Adapter (USA)

REQUEST FOR INFORMATION (RFI)

Introduction

The National Aeronautics and Space Administration (NASA) invites Industry to submit a response to this inquiry to assist NASA in the planning for development of a new Universal Stage Adapter (USA) to integrate primary, co-manifested, and secondary payloads on the Exploration Upper Stage (EUS) of the Space Launch System (SLS). This Request for Information (RFI) is open to responses from all commercial entities. Industry response to this RFI is requested within the context of the requirements and general approach described in the following sections and the associated appendix.

Background

The first launch vehicle being designed, developed, and built as part of the NASA Space Launch System (SLS) Program is designated as the Block 1 configuration. Beyond this initial configuration, a potential upgrade – tentatively designated as the Block 1B vehicle – is being studied by NASA.

For this upgraded configuration, the vehicle core stage, core stage engines, and boosters remain unchanged. The Block 1B vehicle would replace the Interim Cryogenic Propulsion Stage (ICPS) with a more powerful upper stage called the Exploration Upper Stage (EUS) to deliver heavier payloads beyond low Earth orbit (see Figure 1 below). Planning for the Block 1B includes the following USA concepts:

1. USA Baseline: Multi-Purpose Crew Vehicle (MPCV) with Co-Manifested Payloads and Secondary Payloads
    a. A separable adapter which provides a structural interface between the EUS and MPCV, can accommodate co-manifested payloads (significant mission elements such as habitats, communications satellites, in-space telescopes, etc.) and secondary payloads (cubesats or equivalent "small" science or engineering experiments), and allows for the deployment of payloads from within the adapter
    b. Accommodate a payload attach fitting to accommodate co-manifested payloads and allow for deployment of the payload from the attach fitting

2. USA Option 1: Adaptation of the USA for Cargo-only Missions:
    a. Adaptation of the Baseline USA adapter to a payload fairing-type design
    b. Incorporate a payload attach fitting to accommodate co-manifested payloads and allow for deployment of the payload from the attach fitting

3. USA Option 2: Adaptation of the USA for MPCV-only Mission:
    a. Utilize the Baseline USA concept in a fixed (non-separating) adapter which will provide a structural interface between the EUS and MPCV.

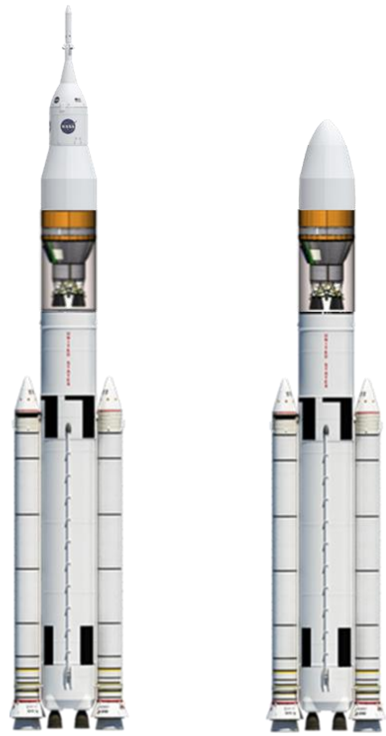
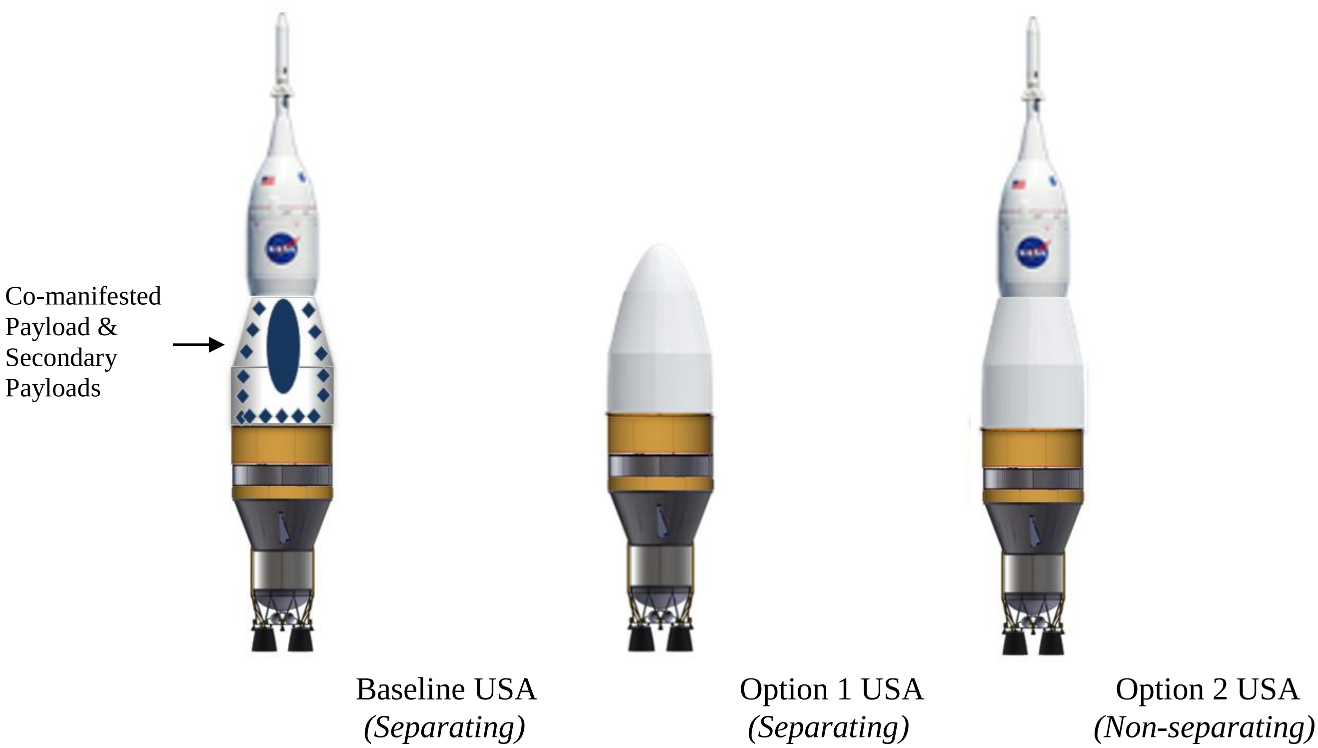


Figure 1
SLS Block 1B Configurations



USA Configurations

Response to this RFI are intended to provide input for an examination into the technology development, design, qualification and manufacture of the USA that meets the needs of the SLS Program, while still meeting NASA programmatic, technical, design, construction, and workmanship approaches and standards for human rating. The Option 1 and 2 USA concepts are intended to leverage Design, Development, Test & Evaluation (DDT&E) and other costs incurred by the Baseline USA to increase SLS affordability. The key metrics of interest to NASA for these concepts are affordability (both DDT&E and Production), reliability, mass, and simplicity of mission operation. NASA is interested in a first launch of the Baseline USA as part of the SLS Program in 2021 and follow-on flights at a rate of up to one per year.

USA Description

The Baseline USA should be a mass-efficient interface between the EUS and MPCV, and accommodate co-manifested and secondary payloads while providing shielding from the external environments. The Baseline USA would be designed, developed, built, and certified for flight consistent with NASA design, construction, workmanship, and qualification standards and other technical and programmatic requirements associated with human rating considerations including configuration management, reliability analysis, and safety assessment processes. Affordability approaches to minimize the development cost to NASA and cost-efficient production and operations are requested. The Option 1 and 2 USA concepts would provide NASA with additional mission capability, while leveraging the DDT&E cost spent on the Baseline USA. Notional assumptions & constraints for the USA concepts are provided in Appendix A.

Requested Response Topics

The specific objective of this RFI is to solicit information that may potentially enhance NASA's planned approach for USA development and assist in formulating the acquisition strategy. Responses are requested but not limited to any of the following topics:

- Configuration, technology assessment, conceptual design, and capabilities – see Table 1 for specific data requested
- Overview of corporate capabilities & flight history that supports the development of the USA concepts
- Proposed long-term affordability considerations including the use of advanced manufacturing methods, minimization of fixed production infrastructure costs, and minimization of variable production and operations costs
- Suggested development costs and manufacturing program costs including top-level schedule and rough order-of-magnitude (ROM) required funding profiles by fiscal year (development costs and manufacturing program costs is requested to be shown separately, not as one cost)
- Suggestions for potential cost sharing opportunities between industry and the Government
- Options for inclusion of small secondary payloads (e.g. cubesats)

- Specific NASA or Industry Standard modifications, tailoring, or alternative approaches that your organization recommends for NASA to meet our key metrics of affordability and performance

Data Request for USA Designs	
No.	**Information Sought**
1	Physical Characteristics Description of potential USA configurations: a. Basic description (subsystem descriptions, e.g., separation, structures, acoustic attenuation, thermal protection) b. Graphical representation with overall dimensions c. Secondary/Co-manifested Payload static envelope d. Structural architecture and projected materials e. Physical attributes (mass, dimensions, etc.) f. Alternative Baseline & Option 1, 2 USA configurations that better support SLS
2	Conceptual Interface Description a. Structural b. Mechanical c. Electrical d. Fluidic e. Graphical representation
3	Fairing Separation Systems a. Basic description (include system redundancy) b. Pyrotechnic shock levels c. Reliability of separation system d. Standard minimum clearance criteria for separation system e. Description of debris minimization for separation system
4	Acoustic Attenuation a. Predicted/demonstrated performance b. Technology maturity c. Integration impacts of design solution
5	Design, Qualification, & Acceptance a. Design loads, factors of safety, and margins b. Technology development requirements c. Qualification & acceptance approach d. Damage tolerance approach
6	Manufacturing a. Manufacturing techniques and processes b. Inspection techniques c. Proposed manufacturing schedule
7	Handling & Operations a. Handling processes and health monitoring b. Concept of operations from manufacturing through delivery at KSC c. Encapsulation & launch operations at KSC d. Separation sequence (excluding USA Option 2)
8	Safety & Risk Mitigation a. Top risks for each USA concept b. Recommended risk mitigation activities and rationale

Data Request for USA Designs	
No.	**Information Sought**
	c. Failure tolerance of each concept
9	Engineering Cost Estimates & Schedule a. Design, development, test & qualification (DDT&E cost) b. Manufacturing, assembly, acceptance & delivery (Unit costs for first 5 units) c. Potential cost reduction opportunities d. DDT&E schedule e. Unit fabrication & delivery schedule
10.	Relevant History a. Data from flight history that drives key trades, analyses and lessons learned b. Potential heritage hardware that could be incorporated

Table 1: Data Request for USA Designs

If a respondent wishes to provide a broader input beyond the topics described above or beyond the technical scope of the USA as described in Appendix A, then it is requested that such alternate responses be submitted separately. However, if a respondent includes an alternate approach than that described in Appendix A, the respondent shall identify which, if any, of the constraints in Appendix A could not be met or would need to be revised to accommodate the alternate approach. The respondent should also identify the cost implications, both impacts and savings, associated with the suggested changes.

Response Instructions

The information obtained will be used by NASA for planning and acquisition strategy development. NASA will use the information obtained as a result of this RFI on a non-attribution basis. Providing data/information that is limited or restricted for use by NASA for that purpose would be of very little value and such restricted/limited data/information is not solicited. No information or questions received will be posted to any website or public access location. NASA does not plan to respond to the individual responses. This RFI is being used to obtain information for planning purposes only and the Government does not presently intend to award a contract at this time. As stipulated in FAR 15.201(e), responses to this notice are not considered offers and cannot be accepted by the Government to form a binding contract. This RFI is subject to FAR 52.215-3.

For the purposes of this RFI, an Engineering Cost Estimate (ECE) is defined as an estimate with line item breakout and rates that provides a financial estimate by fiscal year, to be reported in FY16 dollars.

Sketches have been provided in this RFI for clarification purposes, but are not intended to limit design space. All diagrams are notional mission concepts and subject to change.

In addition to whatever information the responder chooses to provide, each RFI response shall include a cover sheet with the following information:

1. RFI Number and Title

2. Responding Organization (including address, POC and phone number)
3. A brief synopsis of the RFI response in less than 20 words
4. Potential partnerships (industry, international, US government agencies)

The Government is under no obligation to issue a solicitation or to award any contract on the basis of this RFI. The information provided in responses to this RFI will not be made public. Respondents are solely responsible for all expenses associated with responding to this RFI. Responses to this RFI will not be returned, and respondents will not be notified of the result of any assessment.

All responses, including capability statement, should not exceed 50 pages and be provided in MS Word document format via electronic media. Please submit responses no later than August21, 2015, to NASA/MSFC Office of Procurement, Attn: PS42/Okoro Leslie, Contracting Officer, Marshall Space Flight Center, AL 35812 or via e-mail at okoro.d.leslie@nasa.gov and cc: Mark York, Contracting Officer at mark.a.york@nasa.gov.

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APPENDIX A

Preliminary Universal Stage Adapter (USA) Assumptions & Constraints

A.1 Introduction

The assumptions and constraints described below represent the minimum set necessary to define the USA at a conceptual level. All descriptions are notional and subject to change. More expansive and detailed requirements will eventually be generated to define the USA portion of the Space Launch System (SLS) Program. This RFI is intended to inform the development of those requirements.

A.2 USA Assumptions & Constraints

This section contains the essential key assumptions and constraints that would drive the design of USA. All assumptions should be used for the Baseline, Option 1, and Option 2 concepts, except where specifically noted.

A.2.1 USA Mission Descriptions

The Baseline USA provides the structural and electrical interfaces between the SLS Vehicle and the Multi-Purpose Crew Vehicle (MPCV). It will require the rigor of man-rating. It will separate at the MPCV and EUS interfaces after insertion to LEO or other transfer orbit, allowing the MPCV to reconfigure with the co-manifested payload on the EUS. The USA will have the capability to accommodate and shield both co-manifested payloads and/or secondary payloads within its volume. The USA must allow incorporation of any structural attach fittings for these payloads.

The Option 1 USA would utilize the Baseline USA design, but act as a payload fairing for early exploration missions. As opposed to starting from a completely new design, the Option 1 USA will leverage the investment in the Baseline USA, reducing development cost and schedule. It will not require the rigor of man-rating. It would be jettisoned at a point typical of payload fairings (~0.1 BTU/ft^2-s molecular heating rate).

The Option 2 USA would utilize a portion of the Baseline USA design (including the rigor of man-rating), but would not separate from the EUS.

A.2.2 USA Physical Descriptions

A.2.2.1 Primary Structure - Outer Mold Line

The Baseline USA outer mold line dimensions are shown in Figure A-1. The Option 1 USA would include a nosecone with no limitations on design. The non-separating Option 2 USA would utilize the same dimensions the Baseline USA. All configurations have a cone half-angle limit that should not exceed 15 degrees.

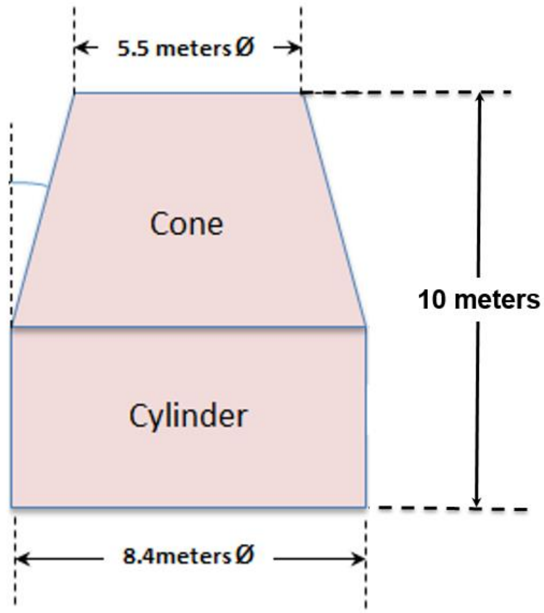

Figure A-1
Dimensions for the Baseline and Option 2 USA Concepts

A.2.2.2 Element Interfaces

The USA physical interfaces with the forward end of the SLS EUS (8.4m diameter) and aft end of the MPCV Spacecraft Adapter (5.5m diameter) are shown in Figure A-2. An EUS to Orion data interface is necessary. Co-manifested payload interface or secondary payload adapter interface is needed for the Baseline USA. Primary payload adapter interface is needed for the USA Option 1. No payload adapter interfaces are needed for USA Option 2. The environmental volume will be shared with EUS LH2 Dome (and Orion SM if applicable).

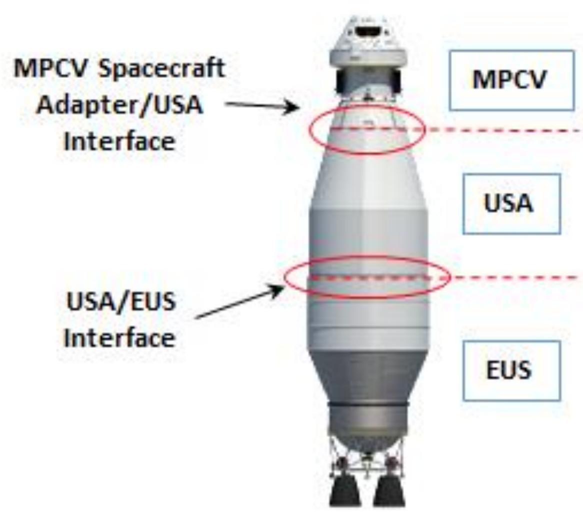

Figure A-2
USA Structural Interfaces

A.2.2.3 Encapsulation

The USA must support vertical encapsulation and integrated lift of the encapsulated payload/USA at KSC.

A.2.2.4 Secondary Payload Access

The USA will provide access to any secondary or co-manifested payloads from encapsulation thru roll-out from the VAB. This is not needed for the USA Option 2.

A.2.2.5 Pre-Launch Services

The Baseline & Option 1 USA concepts will accommodate external services commonly required by payloads after encapsulation such as conditioning for control of temperature, condensation, relative humidity, and cleanliness, and power with the Mobile Launch Platform.

A.2.2.6 USA Separation

The Baseline USA concept will provide a means for reliable contact free separation with no debris generation to allow for release of the co-manifested payload. This includes separation from the MPCV Spacecraft Adapter.

The Option 1 USA concept will provide a means for reliable contact free separation with no debris generation to allow for release of the primary payload at the jettison point (approximately 300 seconds).

Separation is not needed for the USA Option 2.

A.2.3 Flight Conditions & Loads

A.2.3.1 Interface Loads

The Baseline USA and Option 2 configurations will experience a maximum combined load at the MPCV (top, 5.5m diameter) interface as shown in Table A-1.

Table A-1: Max Flight Loads from MPCV

Axial	Shear	Moment
lb	lb	lb-in
200,000	80,000	45,000,000

The Option 1 USA will experience flight loads derived from its mass and aerodynamics loads at a maximum dynamic pressure of 800 psf at 4 degrees AoA and 2g axial acceleration.

A.2.3.2 Acoustic Levels

The USA concepts must provide acoustic attenuation per Figure A-3.

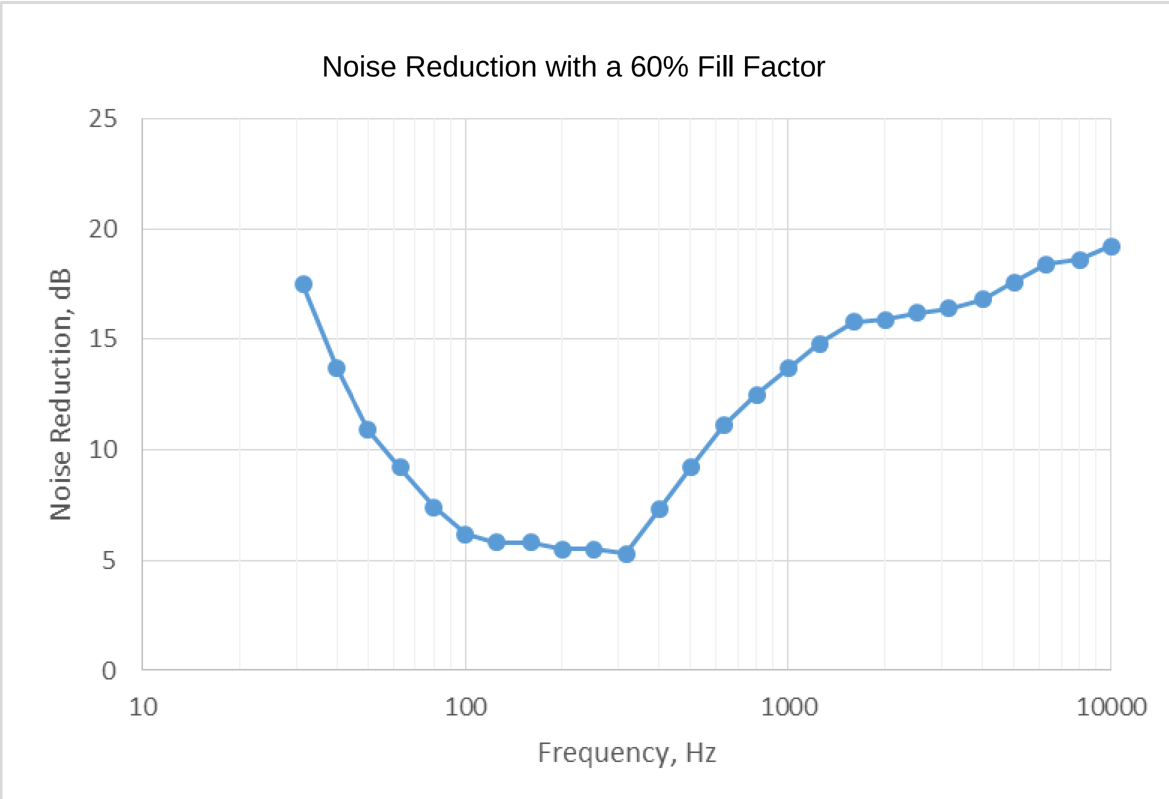

Figure A-3
USA Noise Reduction

A.2.3.2 Aerothermal Heat Rate

The USA concepts will experience the approximate peak heat rate profile shown in Figure A-4.

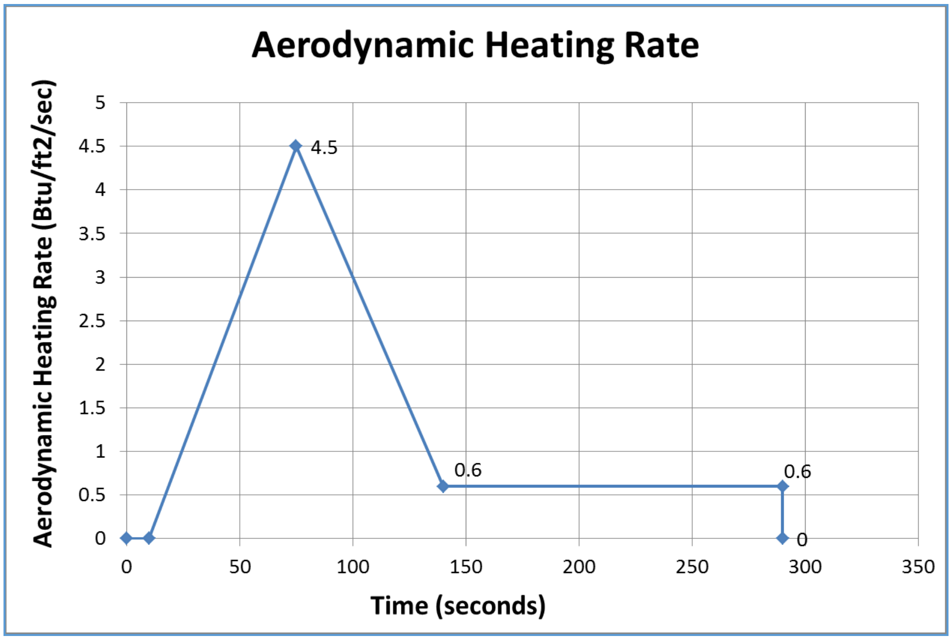

Figure A-4
Simplified Peak Heating Profile for USA Concepts

A.2.4 NASA Standards

A.2.4.1 Structural Standards

The USA concepts must comply with the intent of NASA-STD-5001A, Structural Design and Test Factors of Safety for Spaceflight Hardware, to the extent applicable.

A.2.5 Acronyms

AoA	Angle of Attack
CG	Center of Gravity
DAC	Design Analysis Cycle
dB	decibels
ECE	Engineering Cost Estimate
EUS	Exploration Upper Stage
FAR	Federal Acquisition Regulations
GSE	Ground Support Equipment
ICPS	Interim Cryogenic Propulsion Stage
FAR	Federal Acquisition Regulations
LEO	Low Earth Orbit
Max-Q	Maximum Dynamic Pressure
MPCV	Multi-Purpose Crew Vehicle
NASA	National Aeronautics and Space Administration
OASPL	Overall Sound Pressure Level
PSF	Pounds per Square Foot

RFI	Request For Information
SLS	Space Launch System
SPIE	Spacecraft/Payload Integration and Evolution Element
USA	Universal Stage Adapter